Best Systems Engineering Products Drive CMMI

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Outline

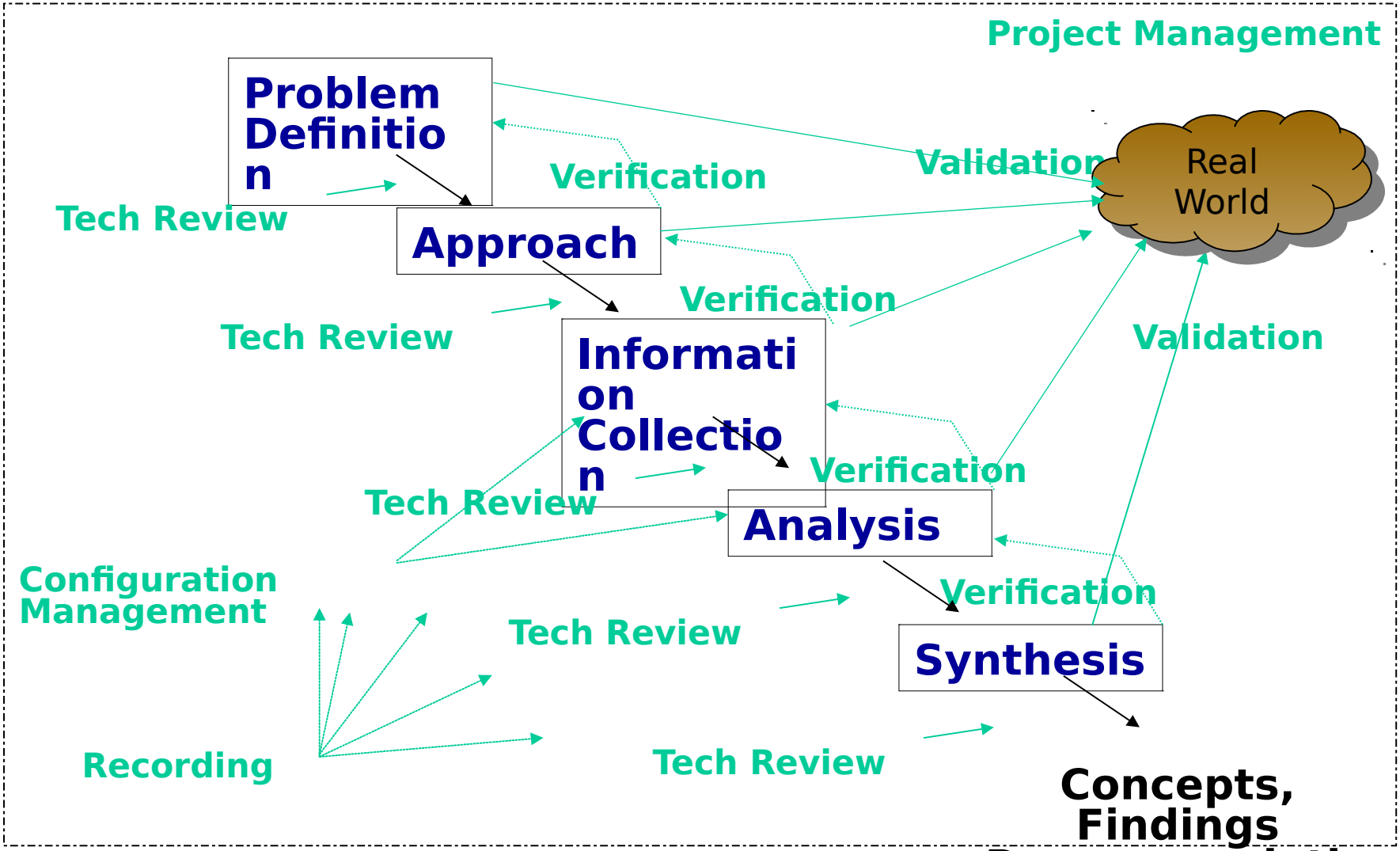
- **Objective**
- **Concept Definition/ Assessments/ Studies Model**
- **System Development Model**
- **Systems Engineering Work Products**
- **Systems Engineering Roles**
- **Process Areas - CMMI[1]**
- **Summary**

1 CMMI is a service mark of Carnegie Mellon University.

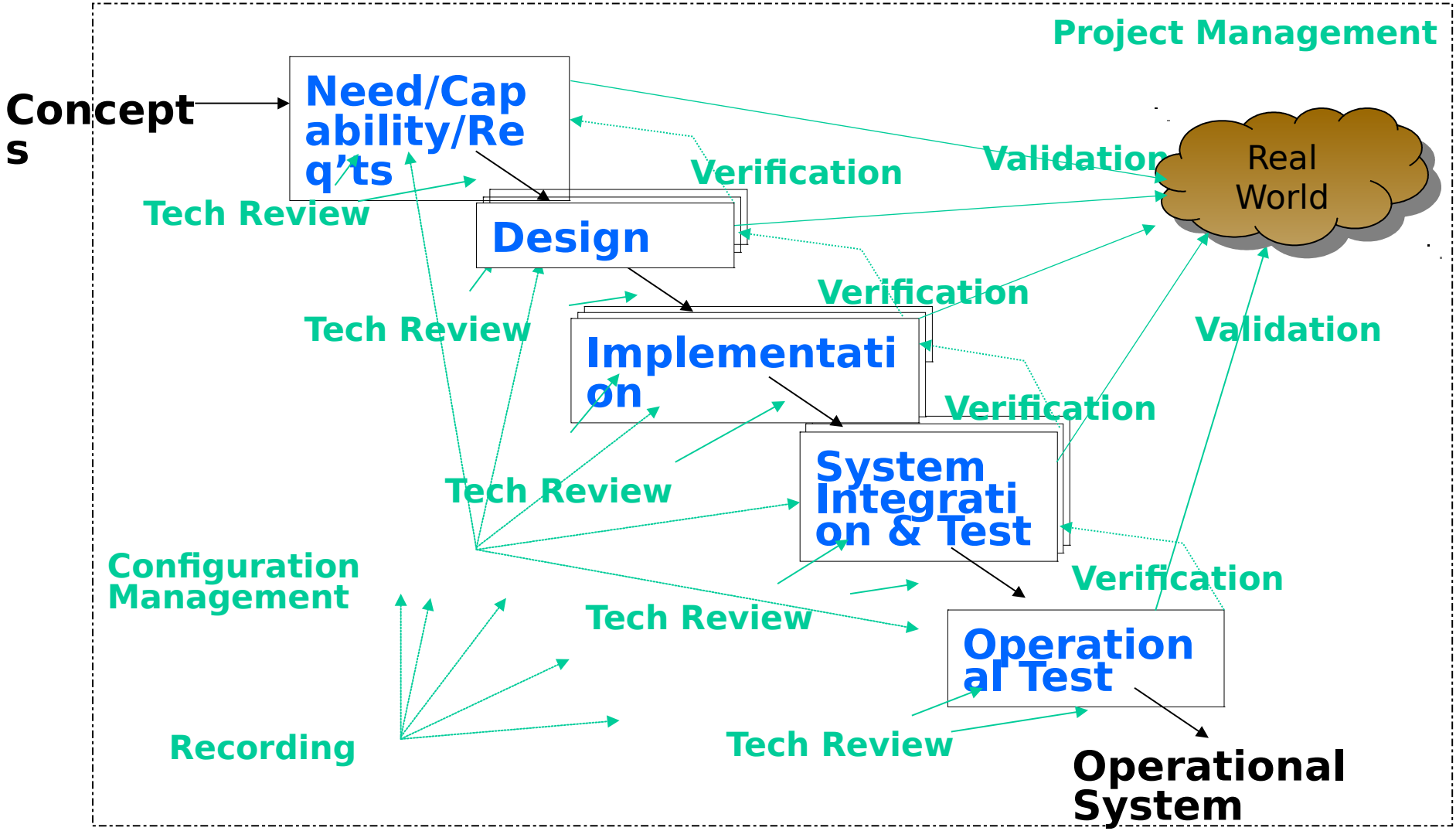
Objective

- **Examine the implications of successful systems engineering work products with respect to the CMMI process areas**

Concept Definition/Studies/Assessments Model
with Continuous Assurance



System Development Model with Continuous Assurance



Systems Engineering Influence on Concept Definition /Studies/Assessments

Systems Engineering Influence on Success: Primary, Secondary

Steps	Example Products
Problem Definition	**Problem Statement, Constraints, Environments, Measures of Effectiveness**
Approach	**Plan of Attack, Tasks, Team Composition, Hypotheses**
Information Collection	
Analysis	**Analysis Report, Potential Solutions**
Synthesis	**Findings, Recommendations, Solution Concepts**

Systems Engineering Influence on System Development Products

Systems Engineering Influence on Success: Primary, Secondary

Steps	Example Products
Need/Capability/Req’ts	Concept of Operation, Operational Requirements, Risk Management Plan, Operational Situations,Test Plan
Design	System Architecture, System Performance Spec, Design Specs (hardware and software), Interface Specs, Trade Studies, Risk Management Plan, Integration Plan
Implementation	Unit Tested Components, As-built Descriptions
Sys Integration & Test	System Test Procedures, System Test Reports, Problem Resolution
	Operational Test Procedures

Systems Engineering Influence on Continuous Assurance Products

Systems Engineering Influence on Success: Primary, Secondary

Steps	Example Products
Verification	Verification Report
Configuration Management	Items Controlled, Change Approval, Baseline Definitions
Validation	Validation Report, M&S Certification Recommendation
Technical Review	Concurrence to Proceed, Actions to be Completed, Appropriate Algorithms/Outcomes
Recording	
Project Management	Work Breakdown Structure, Work Definitions and Deliverables, Schedule, Milestones, Risk Management Plan, Project Status

Relationship of Systems Engineering to System Development and Concept Definition

- **Systems Engineering Involved in All but the Most Detailed Activities**
- **Strong Relationship Between Systems Engineering and Project Management**

Twelve Systems Engineering Roles*

Requirements Owner

System Designer

System Analyst

Validation and Verification Engineer

Logistics/Operations Engineer

Glue among subsystems

Customer Interface

Technical Manager

Information Manager

Process Engineer

Coordinator

Classified Ads SE

*Sarah A. Sheard, “Systems Engineering Roles Revisited”, ***INCOSE MARCH 2000,*** Software Productivity Consortium

Systems Engineering Roles for Concept Definition /Studies/Assessments Products

Example Products	Systems Engineering Roles*
Problem Statement, Constraints, Environments, Measures of Effectiveness	Customer Interface System Designer System Analyst Coordinator
Plan of Attack, Tasks, Team Composition, Hypotheses	System Analyst Technical Manager Coordinator
Analysis Report, Potential Solutions	System Analyst Glue among subsystems Validation and Verification
Findings, Recommendations, Solution Concepts	Customer Interface Coordinator Requirements Owner System Analyst

Systems Engineering Roles for System Development Products

Example Products	Systems Engineering Roles*
Concept of Operation, Operational Requirements, Risk Management Plan, Operational Situations,Test Plan	Requirements Owner Customer Interface
System Architecture, System Performance Spec, Design Specs (hardware and software), Interface Specs, Trade Studies, Risk Management Plan, Integration Plan	Requirements Owner System Designer System Analyst Glue among subsystems
Unit Tested Components, As-built Descriptions	System Designer Validation and Verification Engineer
System Test Procedures, System Test Reports, Problem Resolution	Requirements Owner System Designer Logistics/Operations Engineer

Systems Engineering Roles for Continuous Assurance Products

Example Products	Systems Engineering Roles*
Verification Report	System Designer Validation and Verification Engineer
Items Controlled, Change Approval, Baseline Definitions	System Designer Validation and Verification Engineer Customer Interface Technical Manager Information Manager Coordinator
Validation Report, M&S Certification Recommendation	Requirements Owner Validation and Verification Engineer System Analyst
Concurrence to Proceed, Actions to be Completed, Appropriate Algorithms/Outcomes	Validation and Verification Engineer System Analyst Technical Manager

Implications of Systems Engineering Roles

- **Primary Work Products Involve**
  - **Requirements Owner**
  - **Customer Interface**
  - **System Designer**
  - **System Analyst**
  - **Glue Among Subsystems**
- **Secondary Work Products Involve**
  - **Validation and Verification Engineer**
  - **Technical Manager**
  - **Coordinator**
- **Process Engineering and Classified Ads SE - Emphasis Across Multiple Projects**
- **Information Manager emphasis is data and configuration management**

CMMI Process Categories*

- **Engineering**
  - **Requirements Management**
  - **Requirements Development**
  - **Technical Solution**
  - **Product Integration**
  - **Verification**
  - **Validation**
- **Process Management**
- **Project Management**
- **Support**

*** Chapter 7 of CMMI v1.1 March 2002**

CMMI Relationship to Concept Definition /Studies/Assessments Products

Example Products	CMMI Process Areas
Problem Statement, Constraints, Environments, Measures of Effectiveness	Project Management Support
Plan of Attack, Tasks, Team Composition, Hypotheses	Project Management Technical Solution
Analysis Report, Potential Solutions	Verification Validation Technical Solution
Findings, Recommendations, Solution Concepts	

Relationship : Primary, Secondary

CMMI Relationship to System Development Products

Example Products	CMMI Process Areas
Concept of Operation, Operational Requirements, Risk Management Plan, Operational Situations,Test Plan	Requirements Management Requirements Development
System Architecture, System Performance Spec, Design Specs (hardware and software), Interface Specs, Trade Studies, Risk Management Plan, Integration Plan	Requirements Management Requirements Development Technical Solution Product Integration
Unit Tested Components, As-built Descriptions	Technical Solution Product Integration Verification
System Test Procedures, System Test Reports, Problem Resolution	Technical Solution Product Integration
Operational Test Procedures,	Requirements Management

Relationship : Primary, Secondary

CMMI Relationship to Continuous Assurance Products

Example Products	CMMI Process Areas
Verification Report	Verification
Items Controlled, Change Approval, Baseline Definitions	Requirements Management Support
Validation Report, M&S Certification Recommendation	Validation
Concurrence to Proceed, Actions to be Completed, Appropriate Algorithms/Outcomes	Validation Project Management Support
Work Breakdown Structure, Work Definitions and Deliverables, Schedule, Milestones, Risk Management Plan, Project Status	Project Management

Relationship: Primary, Secondary

CMMI Related Implications

- **Operational Concepts, Requirements and Testing**
  - **Typical Gov’t Role**
  - **CMMI Assumes Start With Firm (Customer) Requirements**
  - **CMMI Not Explicit in this Area**
- **Systems Development Fits CMMI Process Areas**
- **Depth of Domain Knowledge not addressed**
- **Projects/systems Within Single Company Covered**
- **System of Systems Not Applicable - Multiple Companies and Agencies not addressed**
- **CMMI Process Areas Identify Work Products**

Summary

- **Company Systems Development Suited to CMMI**
  - **Common Work Products/Process Areas Within Company/Organization (Industry)**
  - **Concept Development (Gov't) Work Products/Process Areas Not Well Represented**
- **None of the Models, Roles or Process Areas address System of Systems and cross organization/company integrated systems - more attention needed**
- **Methods of measuring goodness of work products and processes needed**
- **Roles of Systems Engineering remain diverse**

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Fred Riedel and Bob Holland of JHU/APL have helped develop the Generic Concept Definition/Studies/Assessments Model, System Development Model and Example Products being used in the Power Projection Systems Department at JHU/APL.

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Definitions - CMMI

- A “customer” is the party (individual, project, or organization) responsible for accepting the product or for authorizing payment. The customer is external to the project, but not necessarily external to the organization. The customer may be a higher level project. Customers are a subset of stakeholders. [FM114.HDA102.HDB103.T101]
- Verification confirms that work products properly reflect the requirements specified for them. In other words, verification ensures that “you built it right.” [FM114.HDA102.HDB121.T101]
- Validation confirms that the product, as provided, will fulfill its intended use. In other words, validation ensures that “you built the right thing.”[FM114.HDA102.HDB122.T101]